Changkat Changi Secondary School

# UNIT 5

# Turning Effects Of Forces

Name: _____

Class: _____

Date: _____

# CONTENT PAGE

## NOTES 5.1

**LESSON OBJECTIVES**

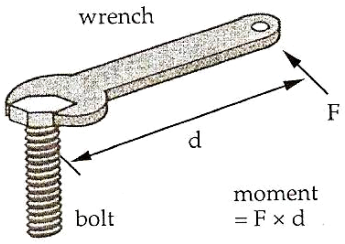
At the end of the lesson, you will be able to:

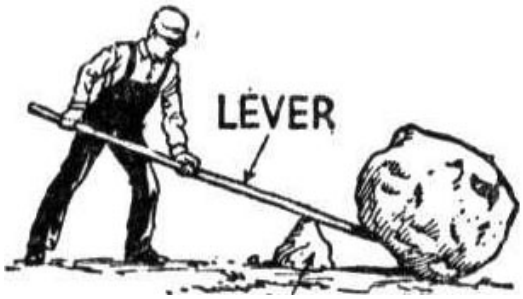
- describe the moment of a force and relate this to everyday examples
- Define and apply moment of a force( or torque) = force x perpendicular distance from the pivot.

1. The turning effect of a force is called the _____ of a force.

2. The moment of a force can cause an object to turn in a _____ or an _____ direction.

Example:




3. In definition:

The moment of a force, *M* about a pivot is the product of the _____ and the _____ from the line of action of the force to the_____.

4. In symbols,

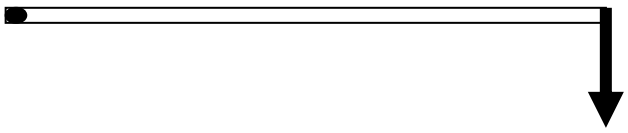
| |
|---|
| |

Where F =
d =

5. The SI unit of moment is the _____ and the moment of a force is a _____.

Example—Calculate the moment exerted by each force below.

(a)



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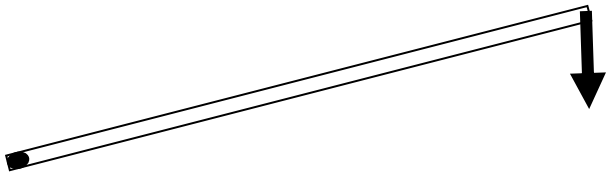
(b)



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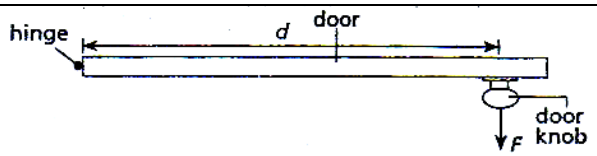
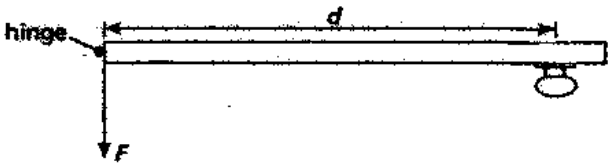
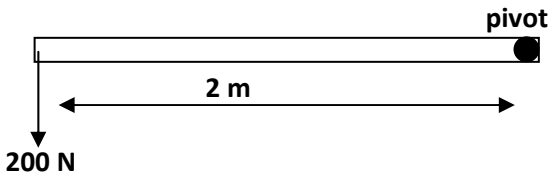
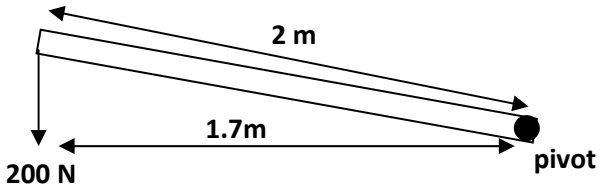
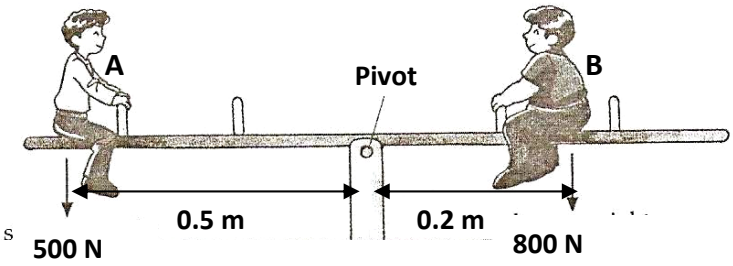
**Calculating moments of a force and determining turning effect**

| Diagram | Moments | Turning effects (clockwise/anticlockwise /nil) |
|---|---|---|
|  | | |
|  | | |
|  | | |
|  | | |

**Balancing objects**




(a) Look at the diagram above, calculate the turning effects exerted due to the weight of the two boys.

(b) What will happen? _____

(c) If it is not balanced, what must happen in order for it to become balanced?

_____

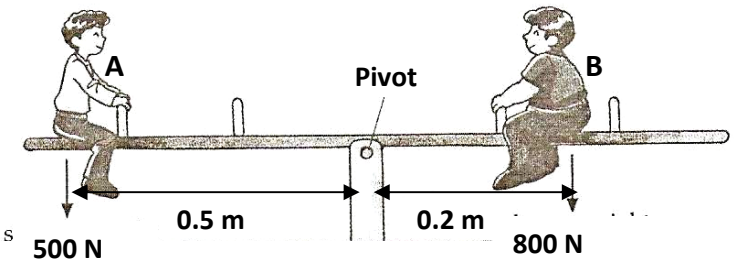
## NOTES 5.2

**LESSON OBJECTIVES**

At the end of the lesson, you will be able to:

- State the principle of moments for a body in equilibrium
- Apply the principle of moments to new situations or to solve related problems

Recall last lesson on turning effects of forces where Boy A and Boy B sits on a see-saw.




In order for Boy A to balance the movement of the see-saw, he has to move towards the pivot. When the see-saw is balanced, this state of the motion is said to be in equilibrium.

Can you recall the formula required to determine the moments exerted by each boy?

**Moment =** F x d ( force x perpendicular distance)

**Principle of Moments**

When objects experiencing turning forces are in a state of balance, we say that the turning effects of forces on the object is balanced.

We use the Principle of Moments to describe this.

The Principle of Moments states that for an object to be in equilibrium, the sum of clockwise moments about the same pivot must be equal to the sum of anti-clockwise moments about the same pivot.

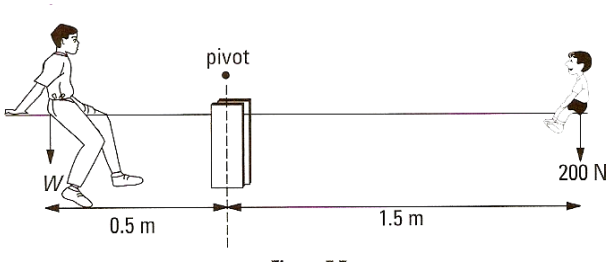
For calculations, we can write that:

***Based on principle of moments,***

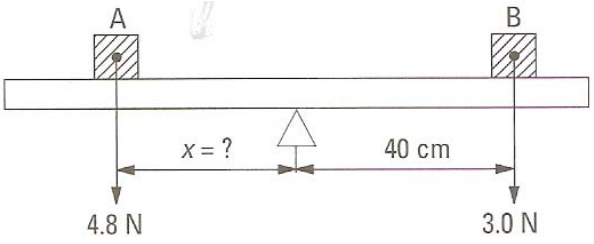
Sum of clockwise moments = Sum of anti-clockwise moments

**Let's try some examples!**

1. A father and son sitting on opposite sides of a see-saw balance each other. Find the weight W of the father.

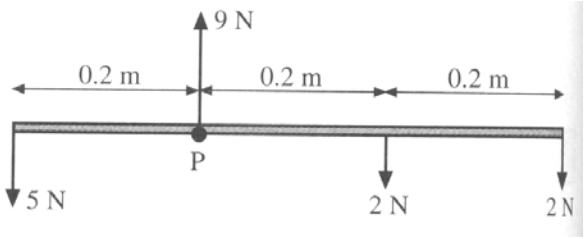



2. The figure below shows a balanced uniform beam supported at its center.




What is the required distance x to balance it?

3. Look at diagram below where a beam is acted by several forces.




If P is the pivot, will it be balanced?

## NOTES 5.3

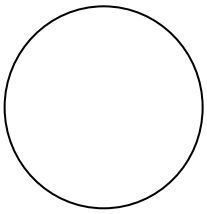
**LESSON OBJECTIVES**

At the end of the lesson, you will be able to:

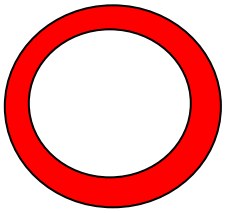
- Show understanding that the weight of a body may be taken as acting at a single point known as its centre of gravity
- Describe qualitatively the effect of the position of the centre of gravity on the stability of objects

Try taking your ruler & balance it using your finger. Can you balance the ruler? If so, at how many cm mark?

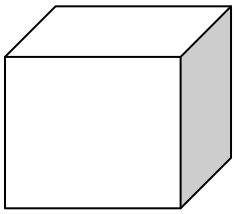
**Define Centre of Gravity**



**Disk**

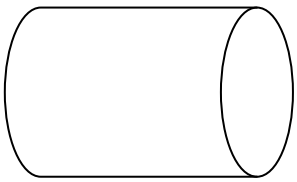


**Ring**



**Cube**

**Dumbbell**



**Cylinder**

Regular shaped objects are of _____ density and _____.
**Note:** For regular shaped objects, the centre of gravity is at the _____
_____ and the centre of gravity can even lie _____ the object.

**Irregular Shaped Objects**

Centre of gravity of an irregular shaped objects can be obtained using the _____.

Finding C.G. of **IRREGULAR** objects such as an irregular lamina or metal plate:

Finding c.g. of an irregular lamina using

……

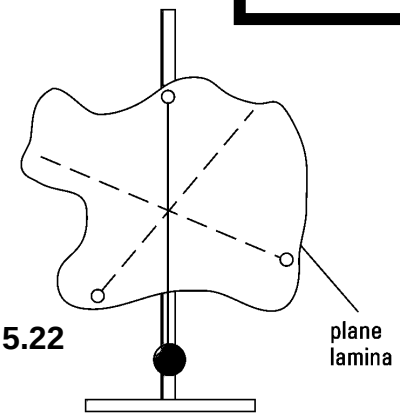



Fig 5.22

**Objective**

To find the centre of gravity of an irregular-shaped lamina

**Apparatus**

Retort stand, plumb line, cork, pin and a lamina

**Procedure**

1. Make three small holes near the edge of the lamina. The holes should be as far apart as possible from one another. An example is given for reference (Figures 5.22 and 5.23).
2. Suspend the lamina through one of the holes using a pin.
3. Hang a plumb line on the pin in front of the lamina.
4. When the plumb line is steady, draw a line on the lamina over the plumb line.
5. Repeat the above for the other two holes.
6. The point of intersection of the three lines is the position of the centre of gravity.

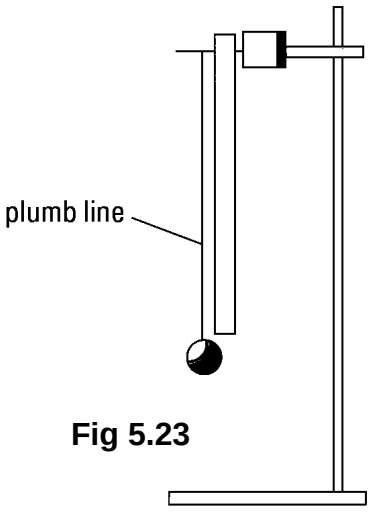



Fig 5.23

**Precautions**

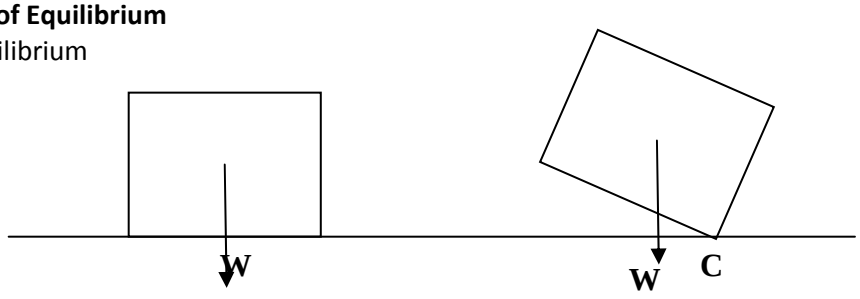
1. The holes must be small so that not too much of the lamina is removed.
2. The lamina should be free to swing about its point of suspension. It will swing about the pin and finally come to a stop.

**What is stability?**

Stability refers to _____. There are 3 types of way to describe stability of an object.

**Three Types of Equilibrium**

1) Stable Equilibrium

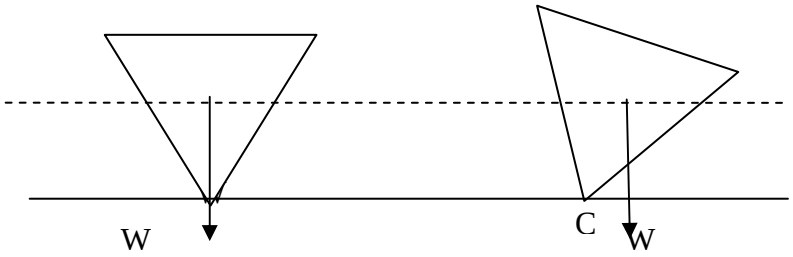



When the object is slightly displaced, it _____.

Note that when you tilt the object,

- The centre of gravity _____ and then _____ back again when the object is released.
- The line of action of the weight W lies _____ the base area of the object.
- The _____ moment of the weight W about the point of contact C causes the object to return to its original position.

2) Unstable Equilibrium

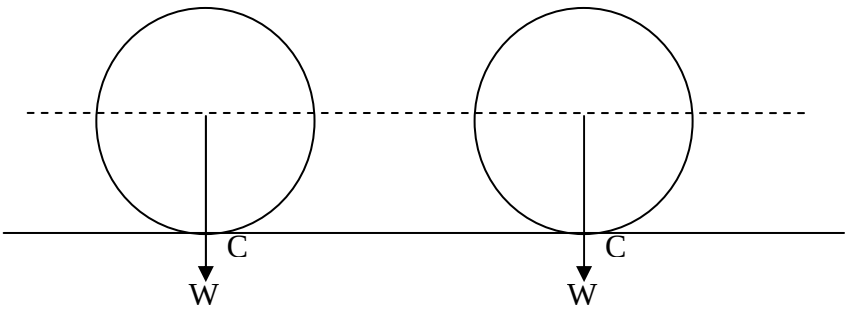



When the object is slightly displaced, it _____

Note that when you tilt the object,

- Its centre of gravity _____
- The line of action of the weight W lies _____ the base area of the object.
- The _____ moment of the weight W about the contact C causes the toppling effect.

3) Neutral Equilibrium




When the object is slightly displaced, it _____

Note that when you tilt the object,

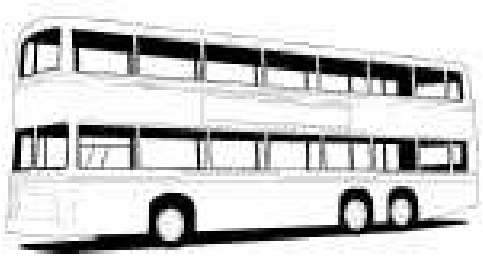
- Its centre of gravity _____; it remains the _____ above the table supporting it.
- There is _____ provided by the weight W about the poi8nt of contact to turn the object.

**How to Increase Stability**

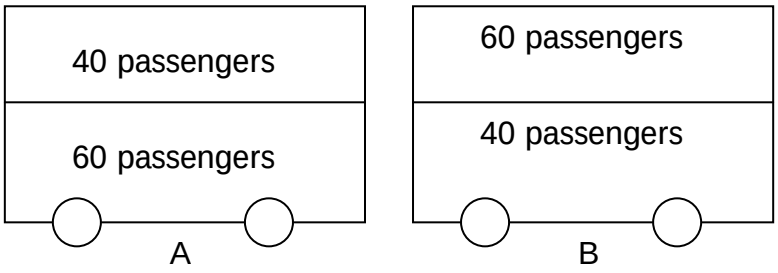
There are two ways to increase the stability of an object:
1) _____ its centre of gravity
2) _____ the area of base.

**Examples**

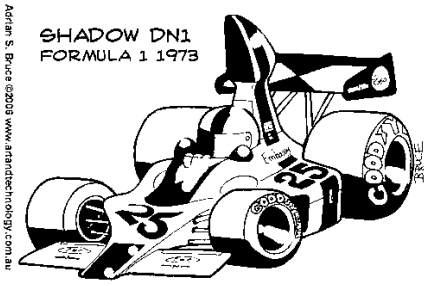
(i) Double decker buses



**Which is more stable when the bus goes around a turn?**




(ii) Racing car




**Why do racing cars have a wide base?**